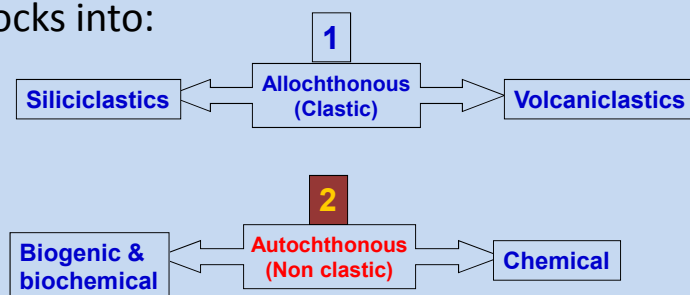


Sedimentary Rocks-2 Non-Clastic Rocks



CLASSIFICATION OF SEDIMENTARY ROCKS

- Hatch et al. (1971) classified the sedimentary rocks into:



Allochthonous Sedimentary Rocks

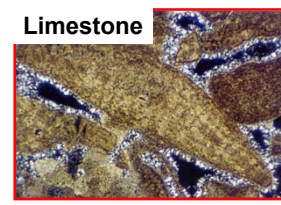
They include

1. Siliciclastic (terrigenous or epiclastic): Conglomerates, breccia, sandstone, mudrock.
2. Volcaniclastics: consist of rock fragments derived from volcanic activity such as volcanic ash and agglomerates.

Autochthonous Sedimentary Rocks

They include

1. Chemical sedimentary rocks such as:
evaporites, ironstones, chert, limestone, dolomite.
2. Biogenic and biochemical sedimentary rocks such as:
phosphate, coal, and special varieties of chert, limestone, dolomite.



CARBONATE ROCKS

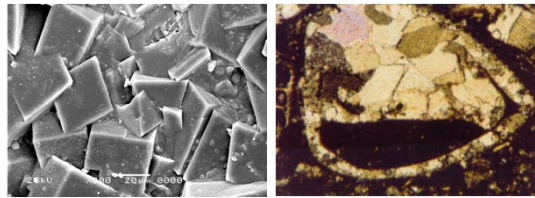
1. Carbonate rocks belong to autochthonous (non clastic) sedimentary rocks.

2. They include:

- *limestone (≥50% calcite)*
- *dolostone (≥50% dolomite).*
- *Inbetween gradation are available such as dolomitic limestone, calcitic dolomite.*

3. Their modes of formation are:

Biological and biochemical processes are dominant in the formation of carbonates with contribution from chemical processes.



ECONOMIC IMPORTANCE OF CARBONATES

- **About half of the world's petroleum reserves are contained within the carbonates rocks. WHY?**
- **Limestones are host to epigenetic lead and zinc deposits.**
- **Limestones are essential raw materials for cement industry.**
- **Limestone used as building stones.**

MINERALOGY OF CARBONATE ROCKS

Aragonite, calcite and dolomite are the most dominant carbonate minerals.

- Aragonite (CaCO_3) is unstable mineral, and crystallizes in orthorhombic system.
- Calcite (CaCO_3) is more stable mineral, and crystallizes in trigonal system.
- Dolomite $\text{Ca Mg}(\text{CO}_3)_2$ crystallizes in trigonal system and may be precipitates primary or replaces the calcite (CaCO_3) by the effect of *dolomitization*.
- Other minerals such as siderite, magnesite, quartz, pyrite, clays, gypsum, anhydrite...etc may be associated with limestones.

COMPONENTS OF LIMESTONES

Components of limestone are:

allochems and orthochems.

- Allochems include skeletal and non-skeletal grains.
- Orthochems are the sparite and micrite.

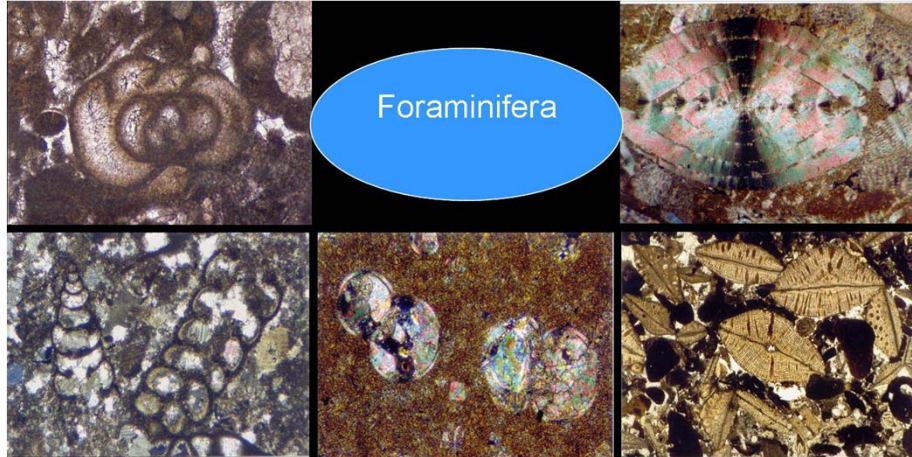
✓ Skeletal grains

Foraminifera, algae, echinoids, mollusca etc.....

✓ Non-skeletal grains

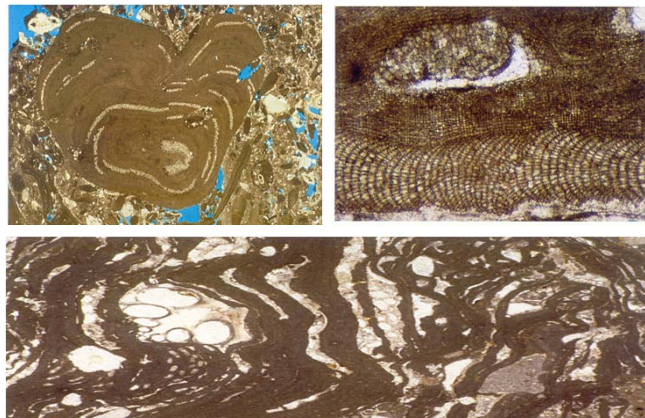
1. Terrigenous grains (Intraclasts or extraclasts)
2. Coated grains (ooliths, pisoliths, oncoliths).
3. Pellets and peloids.

Skeletal Grains



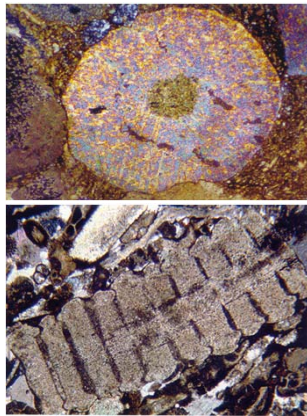
Skeletal Grains

Algae

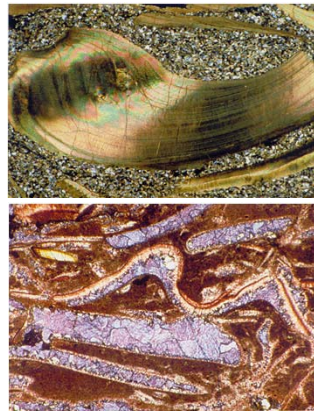


Skeletal Grains

Echinoderms



Mollusca

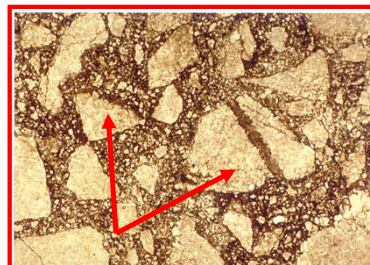


Non-Skeletal Grains

I- Terrigenous grains

1. Intraclasts :

- are fragments of weakly cemented carbonate sediments.
- eroded and redeposited within the same depositional basin.
- characterized for intermittently high energy conditions (carbonate beach, tidal flat).

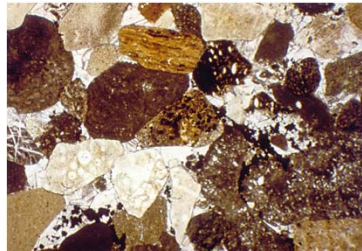


Non-Skeletal Grains

I- Terrigenous grains

2. Extraclasts:

- are lithified carbonates or non carbonate grains.
- derived from outside the depositional basin.
- formed where rapid sedimentation occurs close to the source area (coastal cliffs).



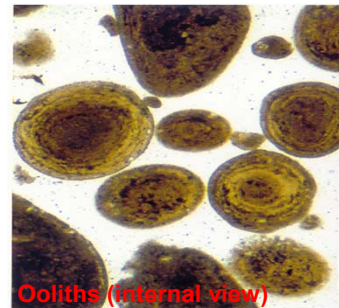
Non-Skeletal Grains

II- Coated grains

They made up of spherical bodies with concentric internal structure and include: oolites, pisolites and oncolites.

1. Oolites:

- ❖ spherical to ellipsoidal grains,
- ❖ 2-0.25 mm in diameter.
- ❖ formed in beach sediments with high energy conditions.

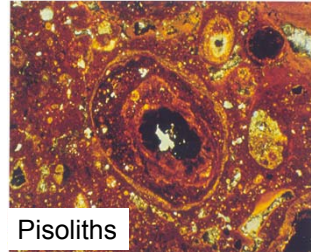


Non-Skeletal Grains

II- Coated grains

2. Pisoliths:

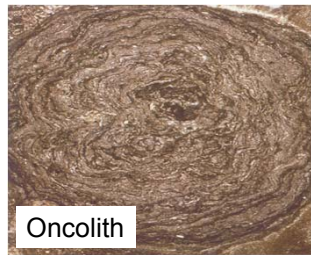
- ❖ similar to ooliths in shape
- ❖ but with larger diameter (more than 2mm). Formed under low energy conditions



Pisoliths

3. Oncoliths:

- ❖ spheroidal coated grains.
- ❖ of algal origin.
- ❖ with irregular lamination.
- ❖ formed in low energy and protected area.



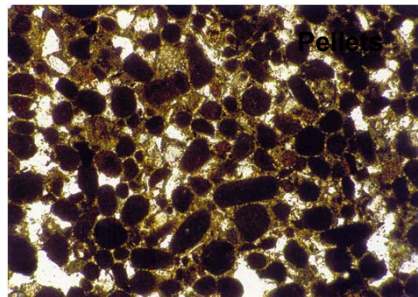
Oncolith

Non-Skeletal Grains

III- Pellets and Peloids

1. Pellets:

- ❖ small, spherical to ovoid or rod shaped grains.
- ❖ composed of micrite.
- ❖ lack internal structure.
- ❖ faecal products of invertebrates.
- ❖ formed in lagoon, low energy tidal flat etc...



Pellets

Non-Skeletal Grains

III- Pellets and Peloids

2. Peloids:

- ❖ no size limit.
- ❖ micritized skeletal fragments.
- ❖ without internal structures.
- ❖ the faecal origin is excluded.
- ❖ formed in protected deeper shelf setting, back barrier etc....



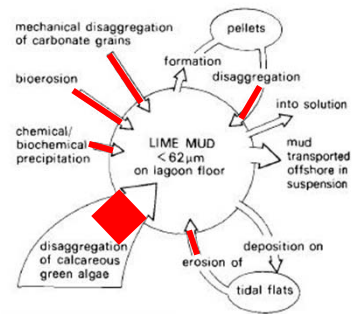
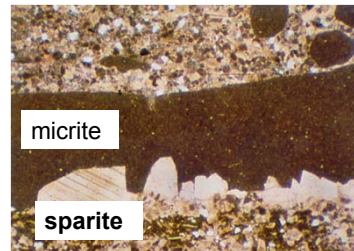
Orthochems

1. Sparite:

- ❖ coarse crystalline calcite,
- ❖ more than 4 microns in size.

2. Micrite:

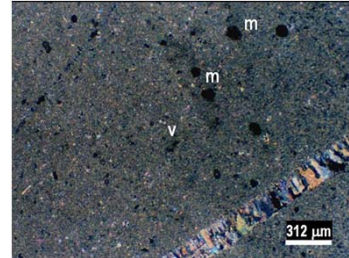
- ❖ microcrystalline calcite ,
- ❖ less than 4 microns in size.
- ❖ It formed by the effect of bio-erosion, mechanical breakdown and biochemical precipitation.



Orthochems

The products of recrystallization of micrite (aggrading neomorphism) are:

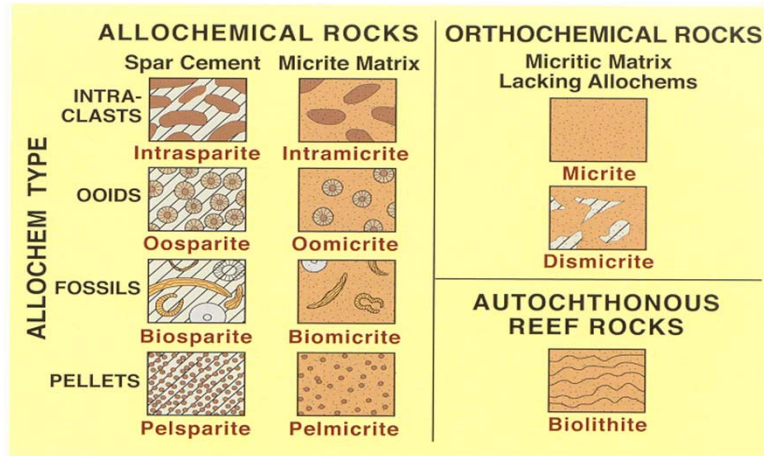
- *Microsparite (up to 30 microns)*
- *pseudosparite (up to 50 microns)*



Classification of Limestones

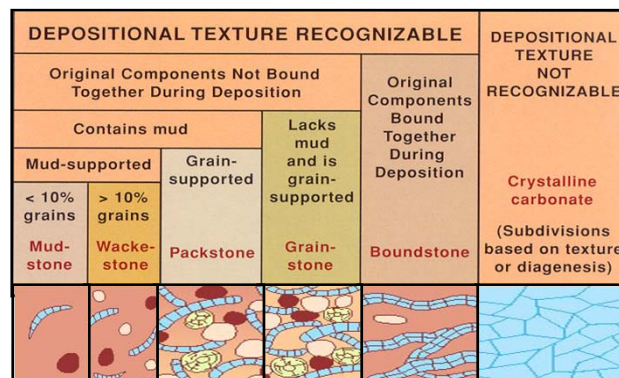
- There are many classification of limestones; the commonly used are those of Folk (1959, 1962) and Dunham (1962).
- Folk classifications depend on the composition; meanwhile Dunham classification depend on the depositional texture.
- Dunham classification is easier than Folk classification because of:
 1. limited number of the used rock types
 2. easy to apply on hand specimens as well as thin sections

Classification of Limestones



Folk Classification, 1959

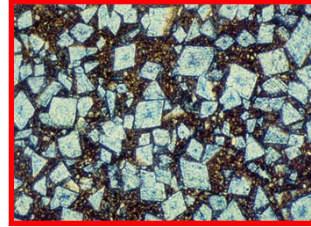
Classification of Limestones



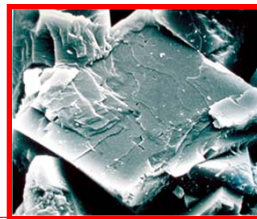
Dunham Classification, 1962

Dolostone & Dolomite

- **Dolostone** is a carbonate rock contains more than 50% dolomite.
- **Dolomite** is a carbonates mineral (Ca Mg CO_3) which may be of primary or secondary origin.



Dolostone

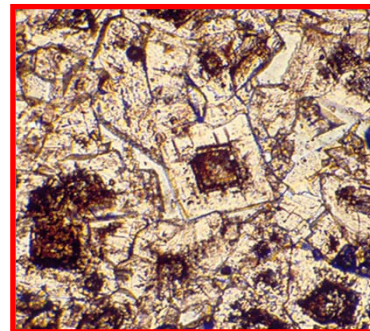


Dolomite rhomb under SEM

Origin of dolomite

Primary dolomite

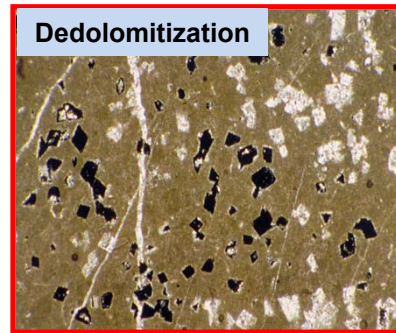
- **Primary dolomite** formed by direct precipitation from sea or lagoon water.
- It is controlled by the high Mg/Ca ratio= 9:1.
- This ratio is raised by the precipitation of aragonite and gypsum-anhydrite.



Origin of dolomite

Secondary dolomite

- ❖ Secondary dolomite is the most common and produced by the effect of dolomitization.
- ❖ Dolomitization is a diagenetic process which means replacement of calcite by dolomite.
- ❖ Dedolomitization is the replacement of dolomite by calcite.



Calcitization is another term to.....?

Dolomitization and reservoir quality

- Dolomitization increase porosity of carbonate rocks by an amount= 13%.
- This fact is related to the compact crystal structure of dolomite than calcite.
- Thus, dolomitization is an important process for hydrocarbon reservoir potential.



Dolomite Classification

- If the original structure has not been destroyed completely, dolomite can be described in the terms of Dunham's and Folk's classifications
- Example according to Dunham's classification:
dolo-mudstone or dolomitic mudstone
- Example according to Folk's classification:
dolo-micrite or dolomitic micrite

